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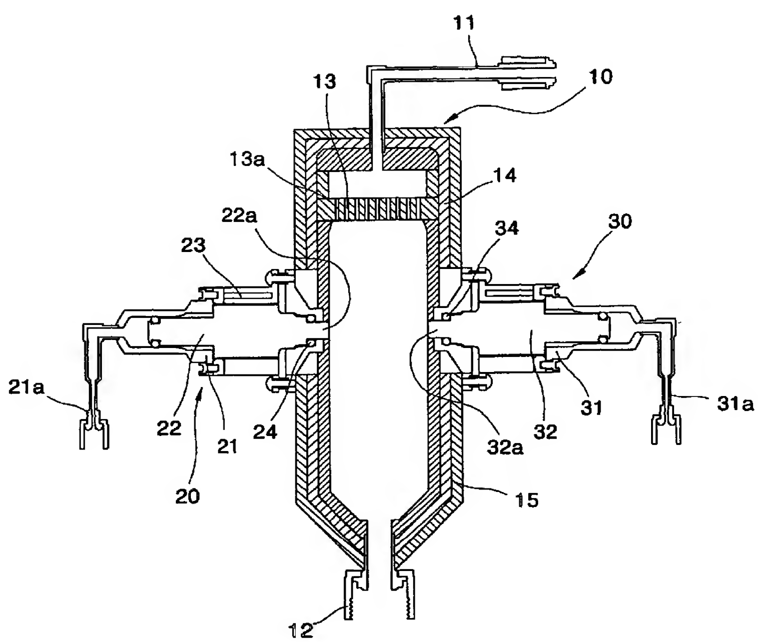
(54) **Title:** VAPORIZER FOR THIN FILM DEPOSITION APPARATUS



(57) **Abstract:** A vaporizer for a thin film deposition apparatus. The vaporizer includes a primary body, which has an innerspace and comprises a transfer gas inlet pipe through which a transfer gas is supplied, a mixed gas outletpipe through which a mixed gas is exhausted, and a first heater which is installed in the primary body to heatthe inner space; and one or more jet units, which are installed on sides of the primary body to jet precursorsinto the primary body.

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VAPORIZER FOR THIN FILM DEPOSITION APPARATUS

Technical Field

The present invention relates to a vaporizer for a thin film deposition apparatus. More specifically, the present invention relates to a vaporizer for a thin film deposition apparatus, which effectively vaporizes one or more precursors and uniformly mixes the precursors with a transfer gas.

Background Art

As integrated circuits (ICs) have become more highly integrated, materials having a high dielectric constant, such as barium strontium titanate (BST) and lead zirconate titanate (PZT), have become strongly relied upon. When atomic film deposition (ALD) or chemical vapor deposition (CVD) is carried out using these materials, it is most important that various precursors required for forming BST or PZT be appropriately processed.

However, because precursors processing is very complicated, it is difficult to embody organic metal compounds needed for forming a thin film of a high degree of purity. Thus, to create organic metal compounds used in ALD or CVD, more attentions are paid to developments in vaporizers capable of precisely controlling precursors, effectively vaporizing the precursors, and uniformly mixing the precursors with a transfer gas.

Disclosure of the Invention

The present invention provides a vaporizer for a thin film deposition apparatus, which enables precise control of precursors, effective vaporization, and uniform mixtures of precursors with a transfer gas.

In accordance with an aspect of the present invention, there is

provided a vaporizer for a thin film deposition apparatus, comprising a primary body, which has an inner space and includes a transfer gas inlet pipe through which a transfer gas is supplied, a mixed gas outlet pipe through which a mixed gas is exhausted, and a first heater installed in the primary body to heat the inner space; and one or more jet units, which are installed on sides of the primary body to jet precursors into the primary body. Each of the jet units includes a pipe body, which is connected to a precursor inlet pipe through which precursors are supplied, a solenoid valve, which is installed in the pipe body and selectively opens/closes off a jet nozzle installed toward the inside of the primary body in response to an external electric signal, and a cooling unit, which is installed at the outside of the pipe body.

The vaporizer for the thin film deposition apparatus further comprises a shower nozzle, which is installed close to the transfer gas inlet pipe in the primary body and includes a plurality of holes. The show nozzle is used to uniformly distribute the transfer gas in the primary body.

The vaporizer for the thin film deposition apparatus further comprises a second heater, which is installed at the center of the primary body to heat supplied precursors, and a sensor, which measures a temperature in the primary body and generates a signal for controlling the first heater and/or the second heater.

The vaporizer for the thin film deposition apparatus further comprises an insulator which is wrapped around the outside of the primary body.

The primary body has a cylindrical shape or a polygonal shape.

The bottom of the primary body has a conic shape such that a mixed gas of a precursor with a transfer gas smoothly flows through the primary body.

Brief Description of the Drawings

FIG. 1 is a lateral sectional view of a vaporizer for a thin film deposition apparatus according to a first embodiment of the present invention;

FIG. 2 is a perspective view of a shower nozzle as shown in FIG. 1;

FIG. 3 is a partial top sectional view of the vaporizer as shown in FIG. 1;

FIG. 4 is a partial top sectional view of a vaporizer for a thin film deposition apparatus according to a second embodiment of the present invention;

FIG. 5 is a lateral sectional view of a vaporizer for a thin film deposition apparatus according to a third embodiment of the present invention;

FIG. 6 is a partial top sectional view of the vaporizer as shown in FIG. 5; and

FIG. 7 is a partial top sectional view of a vaporizer for a thin film deposition apparatus according to a fourth embodiment of the present invention.

Best mode for carrying out the Invention

Hereinafter, the present invention will now be described more fully with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. In different embodiments, the same reference numerals represent the same elements.

FIG. 1 is a lateral sectional view of a vaporizer for a thin film deposition apparatus according to a first embodiment of the present invention. FIG. 2 is a perspective view of a shower nozzle as shown in FIG. 1. Also, FIG. 3 is a partial top sectional view of the vaporizer as shown in FIG. 1.

According to the first embodiment of the present invention, a vaporizer comprises a primary body 10, which has an inner space, and a

first jet unit 20 and a second jet unit 30, which are symmetrically installed with respect to the primary body 10.

The primary body 10, in which a precursor and a transfer gas will be mixed, includes a transfer gas inlet pipe 11, which is installed at the top of the primary body 10 and through which a transfer gas is supplied, and a mixed gas outlet pipe 12, which is installed at the bottom of the primary body 10 and through which a mixed gas is exhausted. The exhausted mixed gas is supplied to a reaction chamber (not shown).

A shower nozzle 13 is installed in the primary body 10 so that the supplied transfer gas can be uniformly distributed. As shown in FIG. 3, the shower nozzle 13 has a cylindrical shape and includes a plurality of holes 13a therein. The shower nozzle 13 allows a transfer gas to be uniformly distributed in the primary body 10 so that the transfer gas can be uniformly mixed with liquid precursors that will be jetted from the first jet unit 20 and the second jet unit 30.

A first heater 14 is installed in the primary body 10 to heat the inside of the primary body. The first heater 14 covers the inside of the primary body 10 and heats a precursor supplied to the primary body 10.

An insulator 15 is installed at the outside of the primary body 10. The insulator 15 is wrapped around the outside of the primary body 10 and prevents the passage of heat into or out of the primary body 10.

The inner bottom of the primary body 10 has a conic shape such that a mixed gas of a precursor with a transfer gas smoothly flows through the primary body 10. Thus, the mixed gas of the precursor with the transfer gas does not pile up in the primary body 10 but can be effectively exhausted through the conic bottom of the primary body 10.

Although, in the present embodiment, the primary body 10 has a conic shape, it is also possible to form a primary body in the shape of a cylinder or a polygon. For example, the primary body 10 may be formed in the shape of a triangular pillar, a square pillar, a pentagonal pillar, or a hexagonal pillar.

The present embodiment adopts two jet units, i.e., the first jet unit 20 and the second jet unit 30, each of which is used to jet a different precursor into the primary body 10. Each of the jet units 20 and 30 includes a pipe body, a solenoid valve installed in the pipe body, and a cooling unit installed at the outside of the pipe body. That is, the jet units of the present embodiment include first and second pipe bodies, first and second solenoid valves, and first and second cooling units. In the present invention, the jet units employ electrically operated solenoid valves. However, it is also possible to use well-known air valves or hydraulic valves.

The first jet unit 20 includes a first pipe body 21 installed at one side of the primary body 10, a first solenoid valve 22, which is installed in the first pipe body 21 and controlled by an external electric signal, and a first cooling unit 23 installed at the outside of the first pipe body 21. Here, a first jet nozzle 22a is installed at one side of the first solenoid valve 22 toward the inside of the primary body 10.

The first pipe body 21 is connected to a first precursor inlet pipe 21a through which a precursor is supplied. The first solenoid valve 22, a known solenoid valve, is used to selectively open/close off the first jet nozzle 22a in response to an electric signal.

The first cooling unit 23 prevents a temperature increase in the first jet unit, more specifically, in the first solenoid valve 22 due to heat supplied from the primary body 10. In the present embodiment, the first jet unit 20 includes a cooling path, which may be wrapped around or place outside the first pipe body 21 and through which cooling water or cooling air flows. The first cooling unit 23 cools the first jet unit 20 to minimize change in quality of a precursor due to heat transmission from the primary body 10.

Meanwhile, a plurality of O-rings 24 may be included to prevent gas in the primary body 10 from flowing backward to the first jet unit 20 or to prevent an external gas from flowing into the primary body 10 and

the first precursor inlet pipe 21a. The O-rings 24 may be installed between the first pipe body 21 and the first solenoid valve 22 or between the primary body 10 and the first jet unit 20.

The second jet unit 30 is almost similar to the first jet unit 20. That is, the second jet unit 30 includes a second pipe body 31 installed at the other side of the primary body 10, a second solenoid valve 32 installed in the second pipe body 31, and a second cooling unit 33 installed at the outside of the second pipe body 31. A second jet nozzle 32a is mounted at one side of the second solenoid valve 32 toward the inside of the primary body 10. Also, the second pipe body 31 is connected to a second precursor inlet pipe 31a through which a precursor is supplied. Since the configuration of the second jet unit 30 is almost similar to that of the first jet unit 20, a detailed description will be omitted here.

Each jet unit can jet a different precursor into the primary body 10 to obtain a desired mixture of precursors.

The dimension of the vaporizer is determined in consideration of the amounts of precursors jetted from jet nozzles, jet pressures of the precursors, and suction pressures of the precursors into the reaction chamber. If the vaporizer includes a plurality of jet units, the dimension of the vaporizer is adjusted so as to avoid interferences between jetted precursors.

For example, depending on whether a thin film is formed of a multiple system thin film, such as $A_XB_XC_X$, or a multi-layered thin film, such as A_XB_X/C_XD_X, the dimension of the vaporizer should be changed. In a case where a thin film is formed of a multiple system thin film, such as $A_XB_XC_X$, and the dimension of a vaporizer is too large, two precursors cannot be uniformly mixed in the vaporizer or a reaction chamber. On the other hand, when a multi-layered thin film, such as A_XB_X/C_XD_X, is deposited, and the dimension of a vaporizer is too small, one jet nozzle may be contaminated by a precursor jetted from another jet nozzle.

Thus, different thin films having desired compositions cannot be obtained. Therefore, the dimension of a vaporizer should be changed according to the thin film type.

The operation of the vaporizer for the thin film deposition apparatus according to the present invention will be described hereinafter.

A transfer gas is supplied through the transfer gas inlet pipe 11, flows through the shower nozzle 13, and is uniformly distributed in the primary body 10. A precursor flows into the first jet unit 20 or the second jet unit 30, is jetted into the primary body 10 by the jet nozzle 22a or 32a, and is uniformly mixed with the transfer gas. Afterwards, a continuously supplied transfer gas allows a mixed gas of the transfer gas with the precursor to flow through the mixed gas outlet pipe 12 into the reaction chamber. Here, since it is possible to precisely control using electricity the solenoid valves 22 and 32 of the first and second jet units 20 and 30, the amounts of the precursors supplied to the primary body 10 can be precisely adjusted.

FIG. 4 is a partial top sectional view of a vaporizer for a thin film deposition apparatus according to a second embodiment of the present invention. Unlike in the first embodiment, the second embodiment uses 3 jet units. The 3 jet units, i.e., a first jet unit 20, a second jet unit 30, and a third jet unit 40, are symmetrically installed with respect to a primary body 10.

The first, second, and third jet units 20, 30, and 40 include first, second, and third pipe bodies 21, 31, and 41, which are symmetrically installed with respect to the primary body 10; first, second, and third solenoid valves 22, 32, and 42, which are respectively installed in the first, second, and third pipe bodies 21, 31, and 41; and first, second, and third cooling units 23, 33, and 43, which are respectively installed at the outside of the first, second, and third pipe bodies 21, 31, and 41. First, second, and third jet nozzles 22a, 32a, and 33a are mounted at one side

of the first, second, and third solenoid valves 22, 32, and 42, respectively. Also, the first, second, and third pipe bodies 21, 31, and 41 are coupled to first, second, and third precursor inlet pipes 21a, 31a, and 41a, respectively, through which respective precursors are supplied. Since the configuration of the vaporizer is almost similar to that in the first embodiment, a detailed description will be omitted here.

FIG. 5 is a lateral sectional view of a vaporizer for a thin film deposition apparatus according to a third embodiment of the present invention. FIG. 6 is a partial top sectional view of the vaporizer as shown in FIG. 5. Unlike in the first embodiment, a primary body 10 of the third embodiment further comprises a second heater 16 independent of a first heater 14 and a sensor 17 capable of measuring temperature in a primary body 10. The second heater 16 is installed at the center of the primary body 10.

The second heater 16 operates independent of the first heater 14 or in synchrony with the first heater 14 and instantly heats a precursor supplied to the primary body 10. Before being supplied to a reaction chamber, a liquid precursor used in CVD or ALD should reach the highest possible atmospheric pressure in the vaporizer. For the liquid precursor to reach the highest possible atmospheric pressure, a very high energy must be instantly applied to the jetted precursor. Accordingly, the second heater 16, in addition to the first heater 14, is installed so that the inside of the primary body 10 can be maintained at a constant temperature and a sufficient energy can be applied to the precursor. Meanwhile, the sensor 17 is used to precisely measure a temperature in the primary body 10 and generates a signal for controlling operations of the first and second heaters 14 and 16.

FIG. 7 is a partial top sectional view of a vaporizer for a thin film deposition apparatus according to a fourth embodiment of the present invention. As shown in FIG. 7, unlike in the third embodiment, the fourth embodiment uses 3 jet units, i.e., a first jet unit 20, a second jet

unit 30, and a third jet unit 40, which are symmetrically installed with respect to a primary body 10.

Although the first through fourth embodiments adopt 2 or 3 jet units, a vaporizer may include one or more jet units.

The vaporizer of the present invention can be used in a CVD apparatus or an ALD apparatus and in any system requiring the improved endurance, uniform film deposition, and improved efficiency due to temperature-controlled surface. The vaporizer can be used not only in many other electric devices but also to deposit one or more insulators, dielectric materials, or conductive materials.

While the present invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

<u>Industrial Applicability</u>

According to the present invention as described above, a primary body of a vaporizer includes a plurality of jet units, which can be instantly controlled using electric signals. Thus, the amounts of precursors supplied from the jet units can be precisely adjusted and uniformly mixed with a transfer gas. Consequently, if the vaporizer is used in a thin film deposition apparatus, a multiple system thin film or a multi-layered thin film having a uniform degree of purity can be effectively deposited.

What is claimed is:

1. A vaporizer for a thin film deposition apparatus, comprising:

a primary body, which has an inner space and includes a transfer gas inlet pipe through which a transfer gas is supplied, a mixed gas outlet pipe through which a mixed gas is exhausted, and a first heater installed in the primary body to heat the inner space; and

one or more jet units, which are installed on sides of the primary body to jet precursors into the primary body.

2. The vaporizer of claim 1, wherein each of the jet units includes:

a pipe body, which is connected to a precursor inlet pipe through which precursors are supplied;

a solenoid valve, which is installed in the pipe body and selectively opens/closes off a jet nozzle installed toward the inside of the primary body in response to an external electric signal; and

a cooling unit, which is installed at the outside of the pipe body.

3. The vaporizer of claim 1 or 2, further comprising a shower nozzle, which is installed close to the transfer gas inlet pipe in the primary body and includes a plurality holes to uniformly distribute the transfer gas in the primary body.

4. The vaporizer of claim 1 or 2, further comprising:

a second heater, which is installed at the center of the primary body to heat supplied precursors; and

a sensor, which measures a temperature in the primary body and generates a signal for controlling the first heater and/or the second heater.

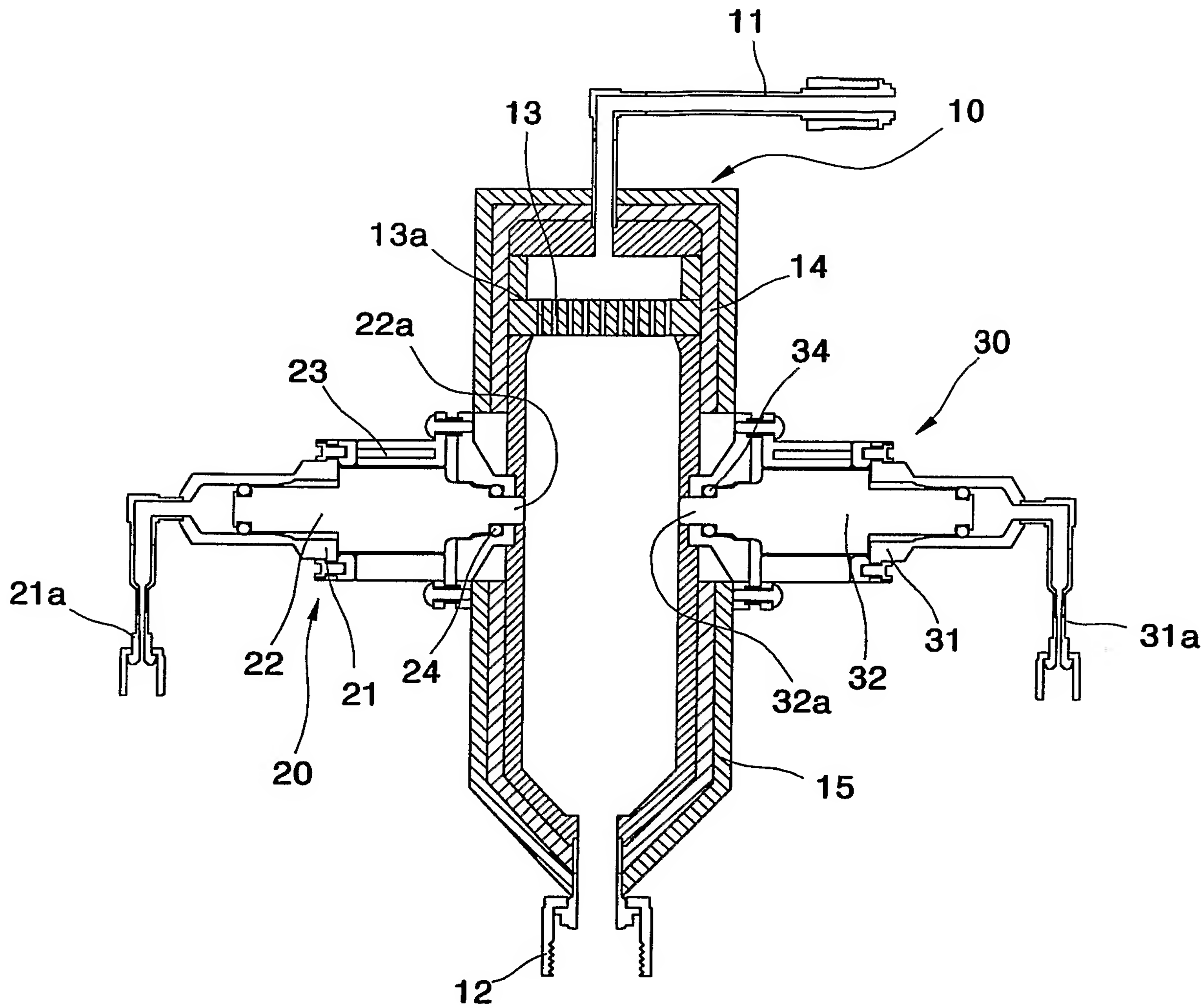
5. The vaporizer of claim 1 or 2, further comprising an

insulator, which is wrapped around the outside of the primary body.

6. The vaporizer of claim 1 or 2, wherein the primary body has a cylindrical shape or a polygonal shape.

7. The vaporizer of claim 1 or 2, wherein the bottom of the primary body has a conic shape such that a mixed gas of a precursor with a transfer gas smoothly flows through the primary body.

FIG. 1


11
13
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12

FIG. 2

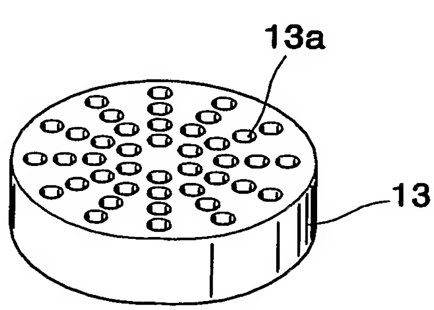
13a
13

FIG. 3

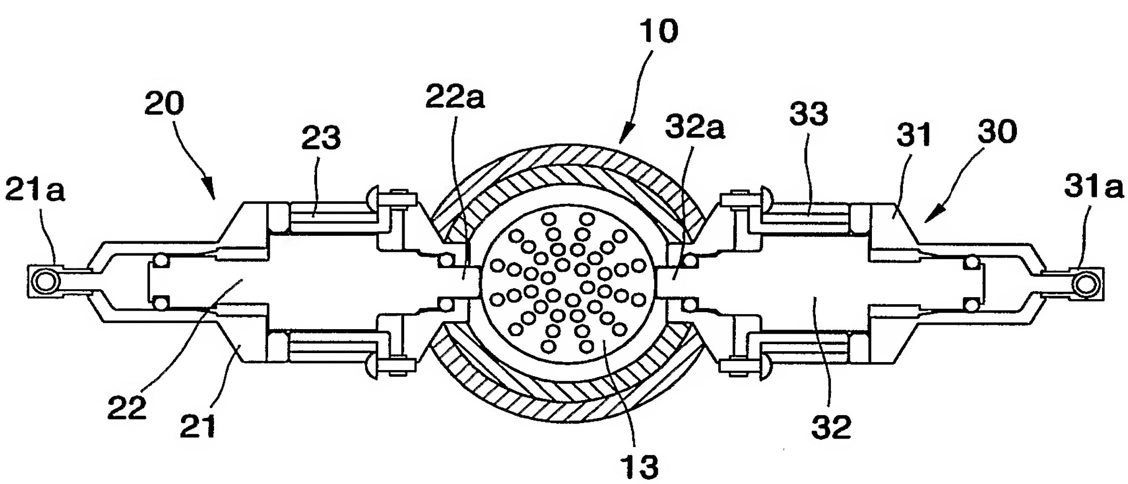

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FIG. 4

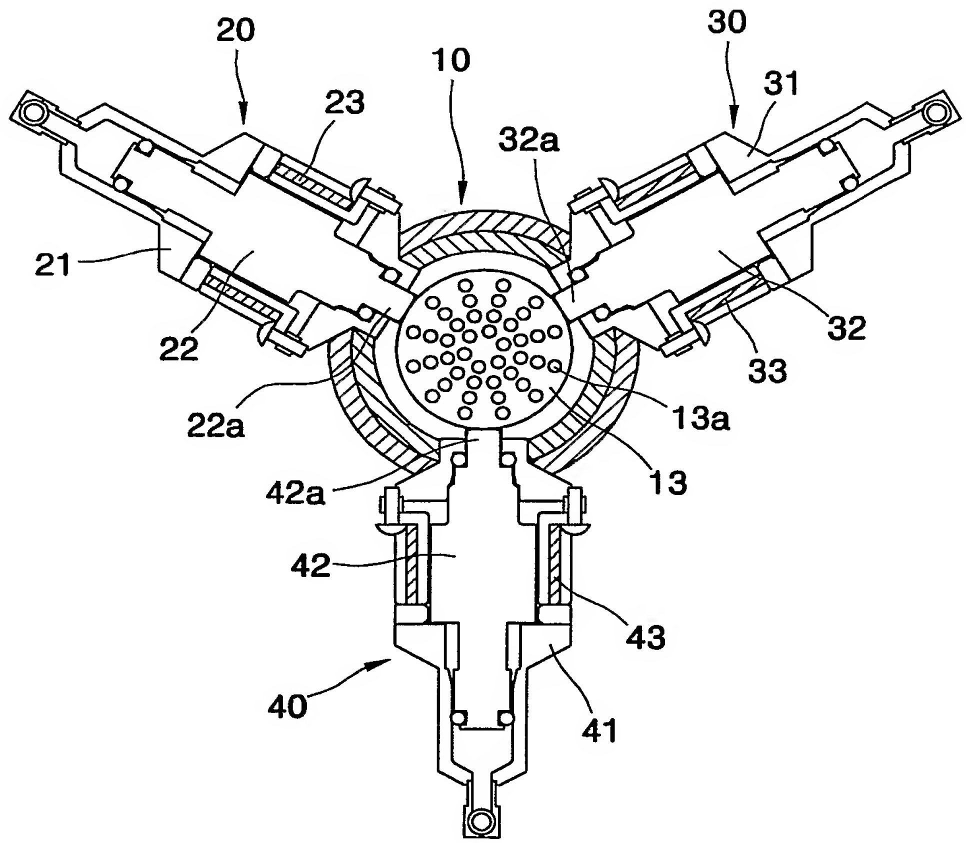


FIG. 5

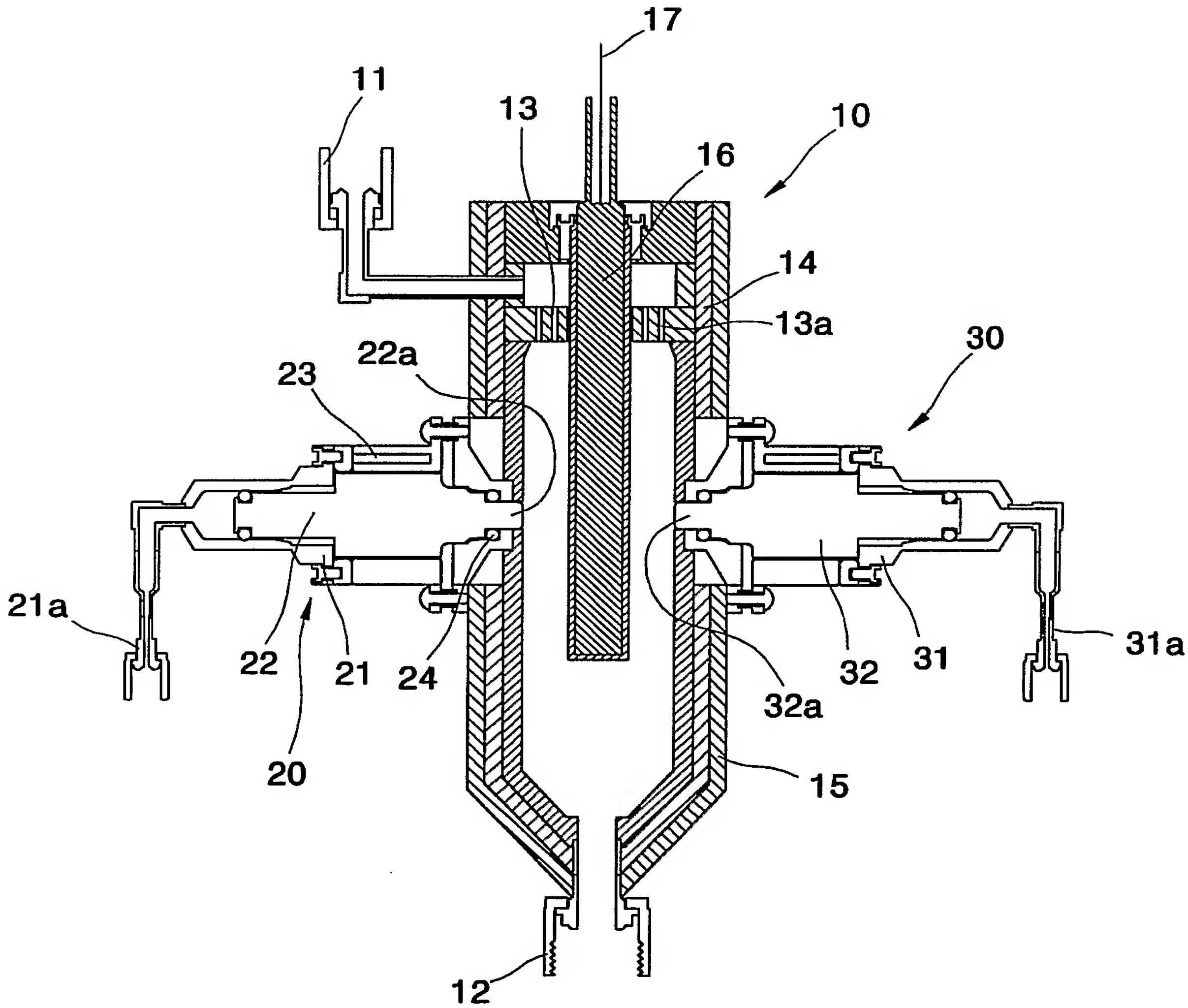


FIG. 6

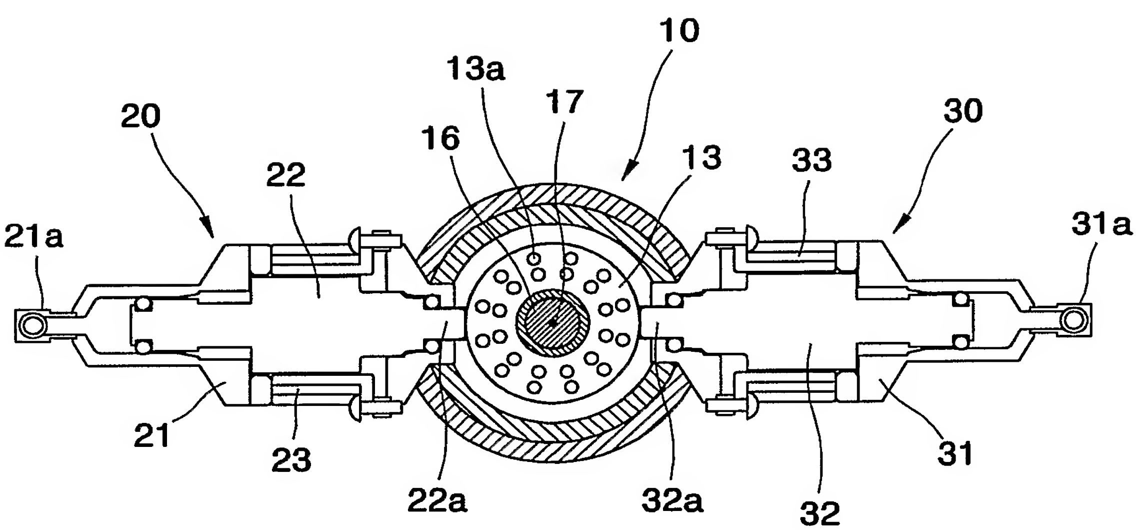
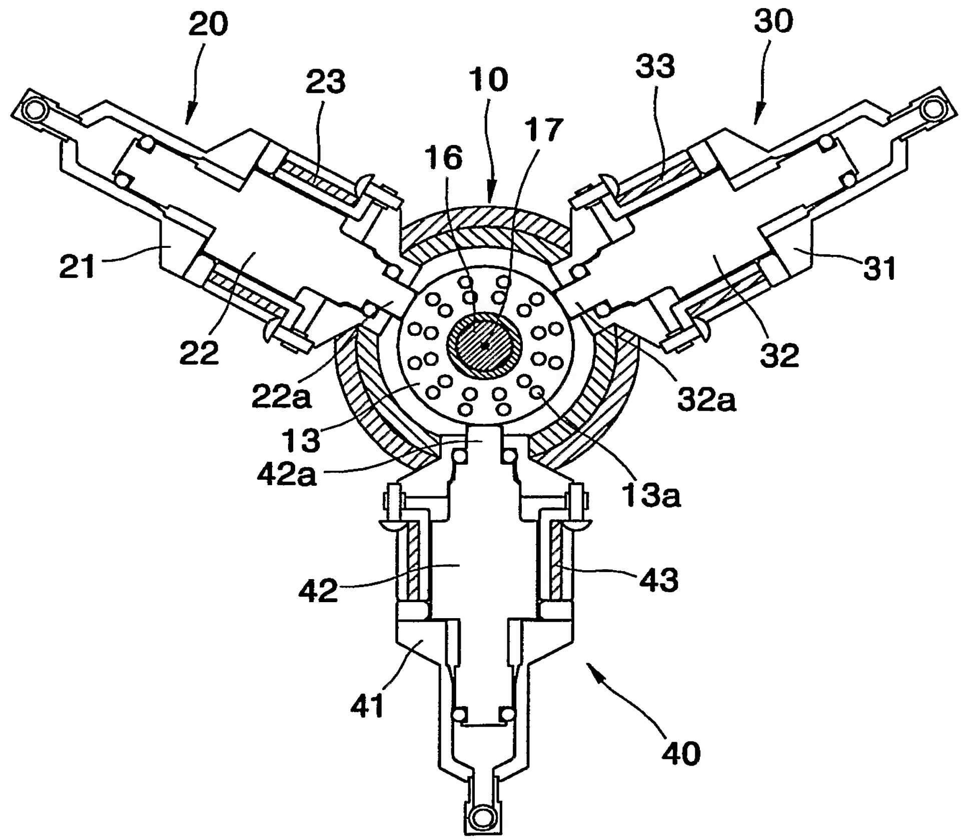


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC7 C23C 16/455

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC7 C23C, B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
KIPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 05-057146 (MITSUBISHI HEAVY IND., LTD.) 9 March 1993 (1993-3-9) the whole document -----	1, 2
Y	US5835678 (EMCORE CORP.) 10 November 1998 (1998-11-10) the whole document -----	1,2
A	US6296711 (CVD SYSTEMS INC.) 2 October 2001 (2001-10-02) the whole document -----	1-7
A	US5595603 1997/01/21 (OSRAM SYLVANIA INC.) 21 January 1995 (1995-09-01) the whole document ------	1-7

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Date of the actual completion of the international search	Date of mailing of the international search report
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